Position Sensitivity for Separating Two γ-ray interactions in a Segmented HP-Ge Detector

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Development of the gamma ray energy tracking array (GRETA) has brought to light many new issues concerning the pulse shape analysis of highly-segemented Ge detectors. One of the most important issues is referred to as position sensitivity [1]. Since the difference in signal shape will be used to determine the locations of γ-ray interactions within the detector, it is important to determine whether this difference is sufficiently larger than that of the noise so that the desired position resolution can be achieved. Studies have shown that the signal difference or position sensitivity is sufficient for locating a single interaction to less than 1 mm in the GRETA prototype detector [2]. Here we extend this study to include the separation of two interactions in a single segment of the detector.

Simulation of detector signals from a single 1.3 MeV γ-ray interaction with a noise level of 5 keV were generated on a 1 mm grid throughout a single segment of the prototype detector. The position sensitivity for separating two interactions was calculated by comparing the difference in signal shape of the average of two signals separated by a grid point to that of the signal at the grid point between them, relative to the noise level. This ratio, between the signal differences and the noise, compared with the grid step size gives the sensitivity along each of the three directions. These calculations were performed for signals along all three-dimensions. The total sensitivity was then calculated as the average of the sum of squares along each direction.

Figure 1 shows the distribution of total sensitivities calculated throughout the examined region of the detector. A mean value of 0.37 mm^2 was obtained. This represents the minimum value of the product of distances that two interaction points must be separated from a third point between them in order for the two to be distinguished from a single interaction at the third location. Such calculations are of great importance since the signal decomposition algorithms for GRETA are designed to allow for multiple interactions within a single segment. The results show that the sensitivity for separating two interactions from that of a single interaction is sufficient in the design of the current prototype detector.

References

1. K. Vetter, et al., Nucl. Instr. and Meth. A 452 (2000) 105
2. K. Vetter, et al., Nucl. Instr. and Meth. A 452 (2000) 223

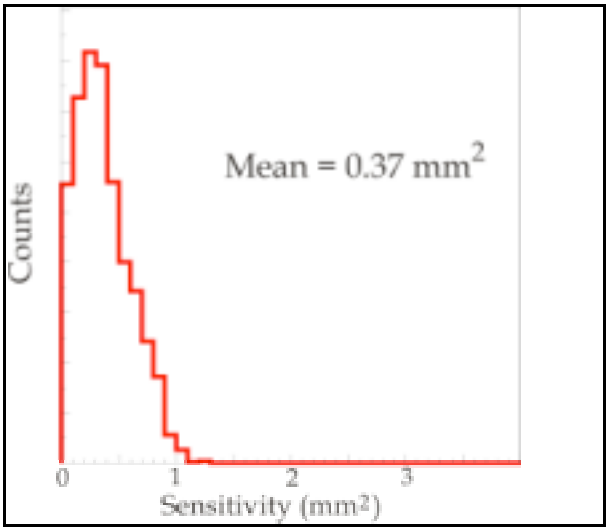

Figure.1. Distribution of total sensitivities for separating two γ-ray interactions calculated in the examined region of the detector. A mean value of 0.37 indicates that in order to separate two interaction points from one in the middle the points must be separated by at least 2 (0.37) or 1.2 mm (for the case of three equal distant poin